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SHORT COMMUNICATION

Flash dewatering for raw sewage effluents

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Abstract: Sewage effluents contain more than 90% water. Basically the dewatering process of sewage effluents is simply a kind of evaporation. Our proposed concept involves a two-phase process that uses what is named "Multi-Stage Flash Evaporation" (MSFE) in handling sewer sewage. The first phase is known as drying, followed by boiling the sludge in the second phase. This leads to the separation of the solids from the water. Dewatered sludge is directed to an incinerator, which produces high-pressure- steam (HPS) that fuels a generator, to produce electricity. The proposed scheme is described and a diagram is presented. Prior to this evaporation step, the water content of the sewage effluents could be reduced to the half by the primary treatment. Water collected at this stage could be utilized for irrigation purposes. The feed to the MSFE unit could be any kind of biomass from sewage sludge, animal byproducts, or agricultural byproducts. Following the study made by Janicki bioenergy using S 200 Omni Processor, it is anticipated to obtain the following results for our proposed scheme. For a daily input of 10 tons of dry feed, along with 70 tons of combined water, an output of 300 KW and 70,000 liters water may be obtained. Further treatment and ultra-refining steps are carried out for the produced water to make it suitable to drink.

Key Words: Dewatering; Multi Stage Flash Evaporation; Incineration; Sewage sludge

INTRODUCTION

Sewage treatment is the process of removing contaminants from wastewater, primarily from household sewage such as: toilet flush, bath tubs, washing machines and others.

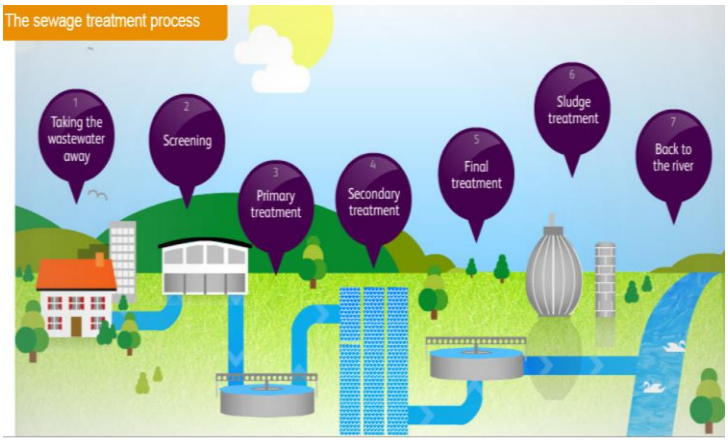

Figure 1: Sewage Treatment Process (after reference 1)

As shown in Figure 1, the treatment process normally involves many steps. Most important is the primary treatment, where the bulk of sludge is separated from the water. The present paper of handling wastewater is triggered by the work done by the Janicki Omni Bioenergy Processor. The JOBP started as a proof-of-concept project, funded by the Bill and Melinda Gates Foundation in 2013. It was originally designed to take in sewer sludge and primarily output electrical power. During the development, it became clear that making clean drinking water made the processor more economically viable, and a water treatment system was added.

Proposed Scheme

It is known that sewage effluents contain more than 90% water. Basically, the dewatering process is simply a kind of evaporation. It is envisaged in this paper to apply the multi stage flash evaporation (MSFE) concept in the evaporation process of sewer sewage. Prior to this evaporation step, the water content of the sewage effluents could be reduced to the half by the primary treatment as illustrated in Figure 1. Water collected at this stage could be utilized for irrigation.

As shown in Figure 2-a, the scheme consists of two stages, or two flashing chambers. Phase one of the process (drying) is represented by two dryers (heat exchangers) in these two stages. The sewage waste effluents, call it the feed, is pumped into the dryer of the first stage located in the top of the flashing chambers. This way it gains heat from the uprising hot water vapor, which condenses as a product. The feed then keeps moving to the next stage, to gain heat by heat exchange. Next comes the second phase in which the sludge is subjected for further heating (boiling) inside the steam heater (phase two).

Now, as this feed enters the bottom of the chamber, stage 2, its temperature is above the boiling point at the pressure maintained at this stage. Therefore, a fraction of the water boils ("flashes") to steam thereby reducing the temperature until equilibrium is reached. The resulting steam is a little hotter than the feed in the heat exchanger. The steam cools and condenses against the heat exchanger tubes, thereby heating the feed water as described earlier. By that time, the sewer sludge has been subjected to boiling; a process which removes all liquid, to be captured as water vapor upon flashing inside the chambers.

The water is collected through troughs located beneath the heat exchangers (A). Further treatment and ultra-refining steps are carried out for the produced water making it suitable to drink.

Dewatered sludge is directed to an incinerator, which produces high-pressure- steam (HPS) that fuels a

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generator. The generator creates electricity that is used as a source of power. There's even a little extra electricity left over that can be transferred into the power grid.

Exhaust steam, on the other hand is used for heating purpose and for steam-jet-ejector to create vacuum. A schematic illustrates the steps explained above is presented as well in Figure 2-b. Based on the results of S 200 Omni Processor and on a daily basis, the following is reported:

1st Plant Input:

- 10-12 tons dry fuel.
- It could be
  - (i) Any kind of biomass from sewage sludge (S.S.)
  - (ii) Animal by-products
  - (iii) Agricultural by-products
  - (iv) Garbage (glass and metal free)

The fuel does not have to be dry as such. It can contain an appreciable amount of water: 12 tons of fuel can hold up to 70 tons of water. Arrangement can be made to have a feed input that contains a mixture of

a) Sewage feed, having more than 90% water.
b) Sludge or other solid material, having 30-90 % water

2nd Plant Output

Three items are produced:

- Power : 300 KW
- Water: 70,000 liters (water produced will be clear and sterile, but with residual odour. Ultra purification equipment is required to make it odour-free).
- Ash: about 10-20% of the dry material input will come out as ash.

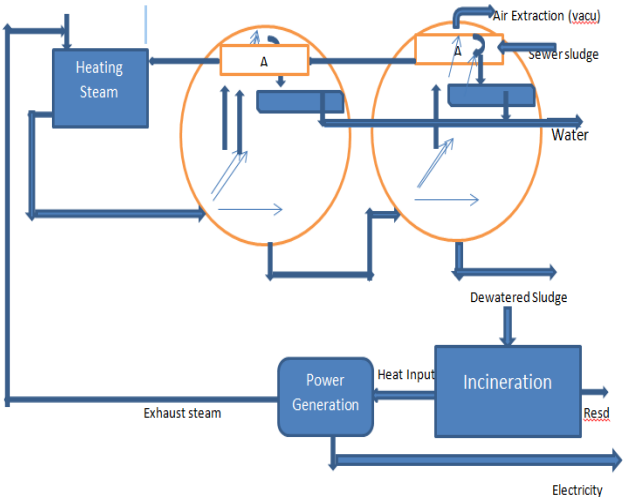

Figure 2a: Proposed Scheme for Treating Sewage Sludge to Produce Water and Electricity

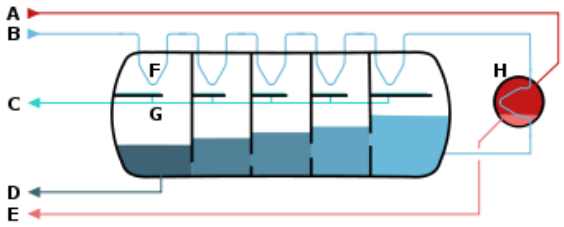

Figure 2b: Schematic of a 'once-through' multi-stage flash evaporator (Modified after reference 6)

Legends:

A - Steam in
B – Sewage feed in
C - Condensed water out
D – Dewatered sludge out
E - Condensate out
F - Heat exchanger
G - Condensation collection of water
H – Sewage steam heater (boiler

CONCLUSIONS

The proposed scheme presented in our paper consists of two stages. However the number of flashing units (chambers) could multiple. This number is a function of the water content and the type of sludge. The advantage of applying vacuum in the first unit is obvious to reduce the temperature in the next units causing flashing of the entering feed. In addition, reduction of vacuum inside the chambers leads to lower operating pressure, hence lower operating temperatures as seen next in Figure 3. Additional economic advantages are obtained when solar energy is considered in heating and boiling instead of steam.

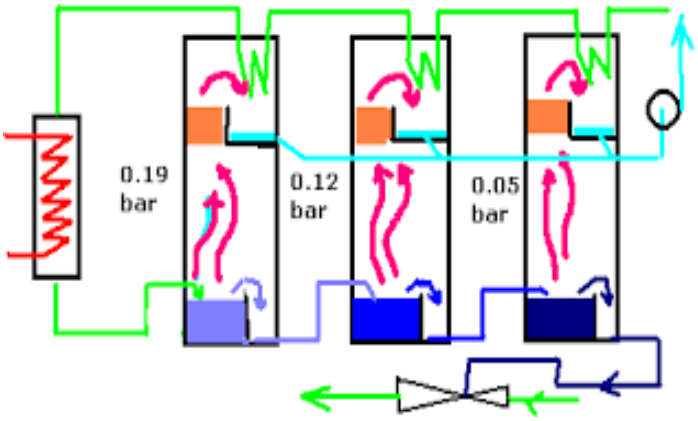

Figure 3: A Module for Multi Stage Flashing Operation (M S F)

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